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CONTRACT NO. DACA33-87-D-0003
DELIVERY ORDER NO. 8
MODIFICATION NO. 1
SEISMIC SURVEY OF SOUTH BEACH
MARTHA'S VINEYARD, MASSACHUSETTS

Prepared for:
Department of the Army
New England Division, Corps of Engineers
Waltham, Massachusetts

Prepared by:
Goldberg-Zoino & Associates, Inc.
Newton Upper Falls, Massachusetts

File No. U-10391.8
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GOLDBERG·ZOINO & ASSOCIATES, INC.
CONSULTING ENGINEERS/GEOLOGISTS/ENVIRONMENTAL SCIENTISTS

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January 10, 1989
File No. U-10391.8-C,PC

Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254-9149

Attention: Mr. Yuri Yatsevitch

Re: Contract No. DACA33-87-D-0003
Delivery Order No. 8
Modification No. 1
Seismic Survey of South Beach
Martha's Vineyard, Massachusetts

Gentlemen:

This draft report presents the results of the subsurface exploration program to assess depths to the dense sand and gravel layer at the former target range on South Beach of Martha's Vineyard, Massachusetts. The work was limited to the area seaward of the dune to the low water line that existed at the time of the explorations.

A contour plan of the top elevation of this dense sand and gravel layer is provided. We will finalize this report once we have your review comments. If you have any questions, please do not hesitate to call us.

Very truly yours,

GOLDBERG-ZOINO & ASSOCIATES, INC.

William H. Hover
Consultant/Reviewer

Nicholas A. Campagna, Jr.
Senior Associate

NAC:rc

GZA

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1.00 INTRODUCTION

Goldberg-Zoino & Associates, Inc. (GZA) performed this study for the New England Division, Corps of Engineers under Contract DACA33-87-D-0003 (Military) Indefinite Delivery Contract for Conducting Geotechnical Engineering and Associated Work, Various Locations in New England and New York, Delivery Order No. 8, Modification 1, dated 30 September 1988 and modified 6 December 1988. The site is on South Beach in Edgartown, Massachusetts on Martha's Vineyard as shown on Figure 1. Our study area was limited to the area seaward of the sand dunes to the low water line at the time of the subsurface exploration program.

1.10 SUMMARY

In early December 1988, the top of the dense sand and gravel stratum varied from approximately elevation +10 on the seaward face of the sand dune to elevation -10.5 near control point 212 in the tidal zone as shown on Figures 2 and 3. At the eastern end, the dense sand and gravel stratum was exposed over a 2,000-foot length at the high water line. There is a near vertical drop in the dense layer. The exposed dense stratum was as much as 2 to 3 feet thick. There were also two other areas shown on Figures 2 and 3 where the dense stratum was exposed at the surface in the tidal zone. Active erosion of the exposed layer was occurring daily in early December 1988.

Over most of the area explored the dense stratum was above elevation -5 except in the tidal zone between control point 209 and 212. In general, the top of the dense stratum slopes downward toward the ocean, but there are some localized higher ridges of the dense stratum.

1.20 PURPOSE AND SCOPE

The purpose of this study was to determine the depth and elevation of a dense sand and gravel layer on South Beach between the dunes and low water within the fenced area of South Beach.

The scope of work included:

1. Establishing a baseline on the beach for survey control. Because of storm erosion this baseline had to be established twice.

2. Performing 46 test borings in two phases to develop data to assess depths to the dense sand and gravel stratum.

3. Performing a seismic refraction survey along the base line on the dry beach.

4. Establishing ground surface elevations of all borings and surface exposures of the dense sand and gravel stratum.

5. Developing a contour plan of the top of the dense sand and gravel stratum.

6. Preparing this report summarizing all of the above.

Originally the seismic refraction survey was going to extend 150 seaward into about 10 feet of water. Sub-bottom profiling from a boat was going to be used for the water work. However, the work was modified by the Corps of Engineers to include the area only out to low water. The changing shoreline condition due to storm erosion also caused the plan for seismic refraction work to be modified and a much more extensive test boring program was substituted as agreed to in Modification No. 1.

2.00 BACKGROUND

2.10 SITE DESCRIPTION

The site is on the southeast side of Martha's Vineyard west of Katama Bay along the Atlantic Ocean between Herring Creek Road at the west end and Katama Road at the east end (see Figure 1). There is a chain link fence around three sides of the site with no fence on the ocean side. The fence is approximately 3,925 feet long along the north side where it borders Atlantic Drive.

Between Atlantic Drive and the Atlantic Ocean there is a 300-foot-wide zone of sand dunes with old dirt access roads throughout the dune area. Along the southern edges of the dunes the dunes typically rise 5 to 10 feet above the beach. However, there are occasional breaks in the dunes for access to the beach.

The beach is predominantly uniform fine to medium sand. The shoreline is irregular and constantly changing. In some areas the high water extends up to the edge of the dunes while in other areas there is as much as a 50-foot-wide zone of sandy beach between the dunes and normal high water. In early October, high water extended to the dunes over approximately 25 percent of the beach length, but by early December high water extended to the dunes over about 75 percent of the beach length. The typical tidal zone between high and low water is approximately 25 to 30 feet wide, but this varies as storms reshape the beach.

2.20 SITE HISTORY

According to the Corps of Engineers, this site was a target range for rockets in the mid-to-late 1940's. At that time the area which is now beach was all dry land. With time the shoreline has receded.

In the Spring of 1988, wave erosion started uncovering old ordnance and washing them up onto the beach. The Navy began investigating the area and began removal of some of the ordnance. They found that the ordnance were primarily in the top 1 foot of a dense sand and gravel layer which was generally 0 to 10 feet below existing ground.

3.00 FIELD STUDIES

The field studies consisted of two phases of borings and a limited seismic refraction survey. Schofield Brothers provided the survey work for horizontal and vertical control.

3.10 LAND SURVEY

Schofield Brothers of Vineyard Haven, Massachusetts established a baseline along South Beach prior to boring and seismic refraction work. They staked control points (numbers 200 through 219 on Figures 2 and 3) at 240-foot spacing along the baseline and determined ground surface elevations at each control point. However, wave erosion due to storms washed away three stakes prior to the first phase of test borings (October 17 through 19, 1988) and twelve stakes prior to seismic refraction survey (October 26 through 28, 1988).

In order to provide better survey control during the second phase of borings, Schofield Brothers reestablished this baseline and were on site to determine locations and elevations as each boring was made. They also located and determined elevations of the top of the dense sand and gravel stratum where it was exposed by wave action in early December 1988.

3.20 TEST BORINGS

GZA Drilling, Inc (GZAD) of Brockton, Massachusetts, performed two phases of test boring probes on the beach (Phase 1- October 17 through 19, 1988; and Phase 2 - December 5 through 8, 1988). Prior to performing each test boring, the U.S. Military checked each location with an ordnance locator. The first phase was checked by U.S. Navy ordnance personnel and the second phase were checked by U.S. Army personnel.

The first phase consisted of fifteen borings (B-200 to B-219 except B-212, 214, 215, and 218) at the control points along the baseline. These were generally spaced 240 feet apart. However, the beach was eroded at control points 212, 214, and 215, so these points were inaccessible for borings.

The second phase of thirty-one borings (B-16 through B-46) were performed between December 5 and 8, 1988. These borings were made in accessible areas above the water line. They were made to provide additional information along the baseline and seaward of the baseline.

The test borings ranged in depth from 3 to 16 feet and averaged about 9 feet deep. The test borings were generally made in uncased holes and were advanced by driving a split-spoon sampler in an open hole. When the driving resistance increased, continuous Standard Penetration test sampling was performed to identify the top of the dense sand and gravel stratum. The drillers obtained at least one sample of the dense sand and gravel in each boring. A summary of the depth to and elevation of the top of the dense stratum in each boring is in Table 1.

3.30 SEISMIC REFRACTION

Dr. Bill Walsh of Geoscience Services Associates of Acton, Massachusetts performed 1,680 linear feet of seismic refraction survey between control points 202 and 209 during October 24 to 28, 1988. Originally the survey was going to be along the entire baseline on dry beach. However, a storm the week before reshaped the beach and washed out stakes over the remainder of the baseline. Also the previously staked area is now in the tidal zone. The wave action in the tidal zone creates so much ground vibrations that it makes interpretation of seismic refraction impossible. Therefore all further seismic refraction work was deleted and supplemented with additional borings in the tidal zone.

The methodology used for the seismic refraction survey is described in Appendix B.

4.00 SUBSURFACE CONDITIONS

The subsurface conditions at South Beach generally consist of a tan, uniform, fine to medium sand over a dense orange-brown sand and gravel layer. Locally there is a black topsoil layer about 2 to 6 inches thick that overlies the orange-brown sand and gravel. This black topsoil layer is present in many areas of the face of the dune where the top of the sand gravel layer is exposed, but seaward of the dunes it was only encountered in borings B-209 and B-210 about 2 to 2-1/2 feet below ground surface. These borings were within 5 feet of the face of the dune.

4.10 TAN FINE TO MEDIUM SAND

The tan, uniform, fine to medium sand is generally very loose at the surface and increases in density with depth. It is generally loose to about 5 feet and increases to medium dense below that level where it extends that deep. It generally varies from about 2 to 14 feet thick. Most of the areas where it is greater than 10 feet thick are between control points 206 and 212 in the central portion of the site.

4.20 BROWN SAND AND GRAVEL

The orange-brown dense to very dense sand and gravel stratum varies from well-graded fine to coarse sand to sand and gravel. The silt content typically varies from 5 to 10 percent. The Standard Penetration resistance at the top of this stratum as noted in Table 1 is greater than 30 blows per foot except in borings B-43, B-44, and B-45.

The elevation of top of the dense sand and gravel layer as noted in borings and confirmed in the limited seismic refraction survey varies from +7 at B-201 to -10.5 at B-27. A summary of these elevations is provided in Table 1 and contours of the top elevation of this stratum are presented on Figures 2 and 3. In addition to the boring and seismic refraction data, the top of this stratum was exposed by wave erosion in early December 1988 in localized areas of the beach and in the face of the dune at the eastern end of the beach. Spot elevations of these exposures are noted on Figures 2 and 3.

In general, the highest elevations of the sand and gravel stratum are closest to the dune and slope downward toward the ocean. However, there are some localized high ridges such as in the vicinity of borings B-33, B-37, and B-39. In the area between control points 211 and 212 the surface drops steeply toward the ocean, but it is much more gradual in other areas.

5.00 LIMITATIONS

As noted in Appendix A, the soil profile and contours of the top of the dense, brown sand and gravel stratum convey the general trends in subsurface conditions in early December 1988 based on widely spaced borings. Actual soil transitions are probably more erratic. Also the wave action will continue to change the soil profile due to erosion and deposition.

TABLE NO. 1

BORING SUMMARY

Boring No	Surface Elevation[1]	Depth to Dense Stratum	Elev. of[2] Dense Stratum	Date of Boring	SPT[3] Resistance Blows/ft
B-201	13±	6	+7(±)	10/18/88	36
B-202	9.0	3.7	+5.3	10/19/88	135
B-203	8.8	8	+0.8	10/19/88	64
B-204	8.9	7.8	+1.1	10/19/88	85
B-205	11.3	9.7	+1.6	10/19/88	49
B-206	10.4	10.0	+0.4	10/18/88	72
B-207	8.7	14.0	-5.3	10/18/88	70
B-208	8.7	11.0	-2.3	10/18/88	49
B-209	9.1	2.4	+6.7	10/18/88	82
B-210	6.5±	2.7	+3.8(±)	10/19/88	110
B-211	6.5±	2.0	+4.5(±)	10/19/88	154
B-213	4.0±	2.0	+2.0(±)	10/19/88	80
B-216	4.0	2.0	+2.0	10/19/88	77
B-217	6.2±	4.0	+2.2(±)	10/18/88	94
B-219	9.0±	11.8	-2.8(±)	10/18/88	90
B-16	6.9	6.0	+0.9	12/5/88	34
B-17	5.3	2.0	+3.3	12/5/88	63
B-18	6.8	7.0	-0.2	12/5/88	55
B-19	8.5	9.0	-0.5	12/5/88	75
B-20	6.0	9.0	-3.0	12/5/88	34
B-21	6.6	11.5	-4.9	12/6/88	37
B-22	5.3	7.8	-2.5	12/6/88	42
B-23	4.0	6.0	-2.0	12/6/88	31
B-24	4.4	7.5	-3.1	12/6/88	62
B-25	4.7	13.5	-8.8	12/6/88	70
B-26	2.6	12.0	-9.4	12/6/88	45
B-27	3.2	13.7	-10.5	12/6/88	48
B-28	3.6	4.0	-0.4	12/6/88	47
B-29	6.2	10.5	-4.3	12/7/88	42
B-30	7.4	5.5	+1.9	12/7/88	63
B-31	6.2	7.0	-0.8	12/7/88	61
B-32	6.5	11.8	-5.3	12/7/88	61
B-33	11.3	7.0	+4.3	12/7/88	89
B-34	8.4	6.0	+2.4	12/7/88	70
B-35	10.7	7.5	+3.2	12/7/88	72
B-36	10.2	10.0	+0.2	12/7/88	46

TABLE NO. 1 (CON'T)

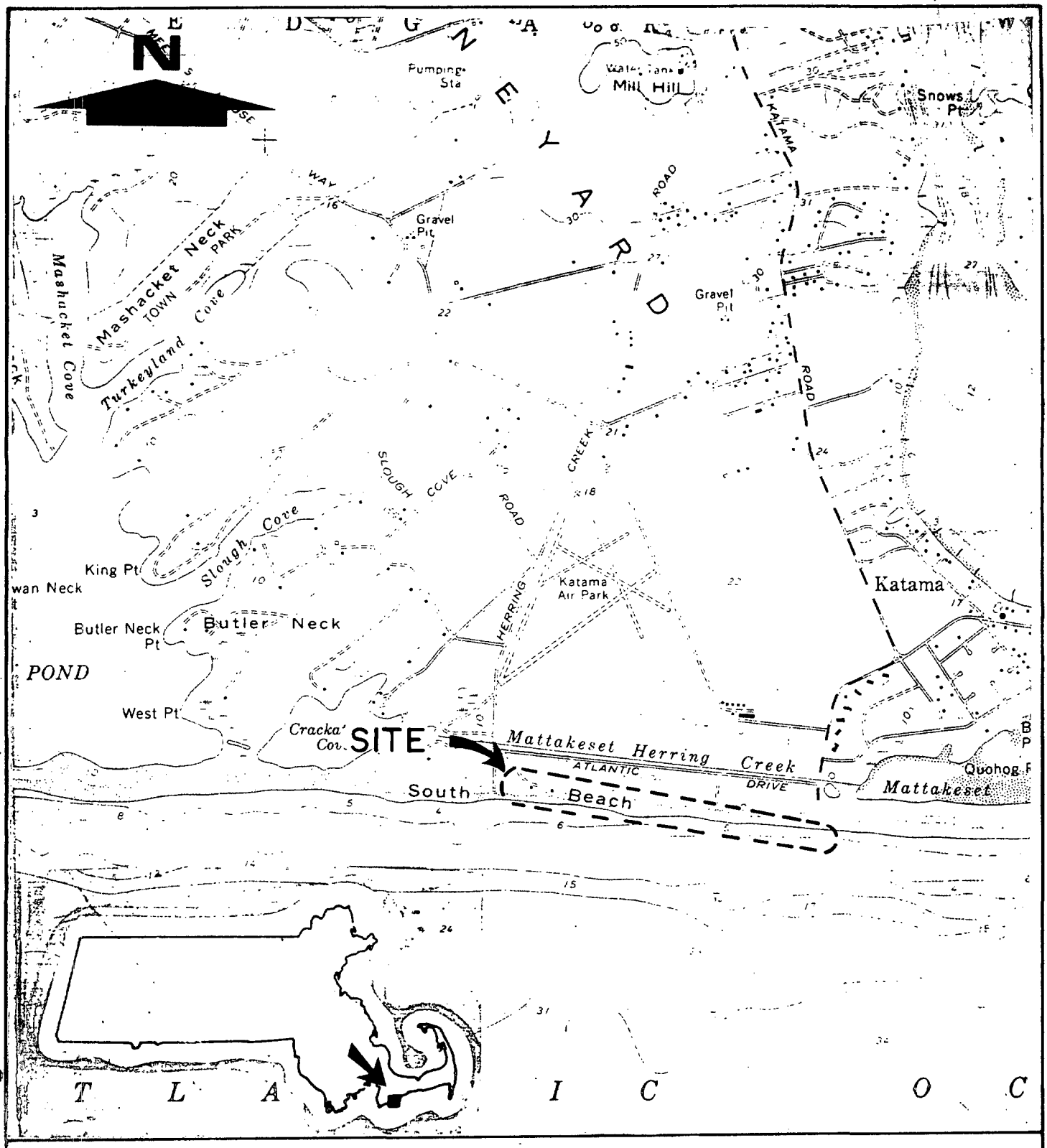
Boring No	Surface Elevation[1]	Depth to Dense Stratum	Elev. of[2] Dense Stratum	Date of Boring	$SPT^{(3)}$ Resistance Blows/ft
B-37	11.3	8.5	+2.8	12/7/88	50
B-38	10.0	13.8	-3.8	12/7/88	71
B-39	8.3	5.0	+3.3	12/7/88	80
B-40	7.8	5.0	+2.8	12/8/88	62
B-41	6.2	13.0	-6.8	12/8/88	54
B-42	7.6	3.5	+4.1	12/8/88	76
B-43	3.8	5.0	-1.2	12/8/88	26
B-44	8.0	6.5	+1.5	12/8/88	16
B-45	3.4	2.0	+1.4	12/8/88	26
B-46	2.8	7.5	-4.7	12/8/88	33

1. All elevations are in feet and are referenced to NGVD.

2. $\pm$ indicates elevations are only approximate because survey stakes were washed away at these locations.

3. Standard Penetration Resistance in blows per foot for samples taken at top of orange-brown coarse to fine sand and gravel stratum.

FIGURES



0' 1000' 2000' 4000'

SOURCE: USGS EDGARTOWN, MA
QUADRANGLE MAP (1972)

FILE No. U-10391.8

143414

MAKEPEACE

SOUTH BEACH SEISMIC SURVEY

EDGARTOWN, MASS

LOCUS PLAN

DEC. 1988

FIGURE No. 1

138635

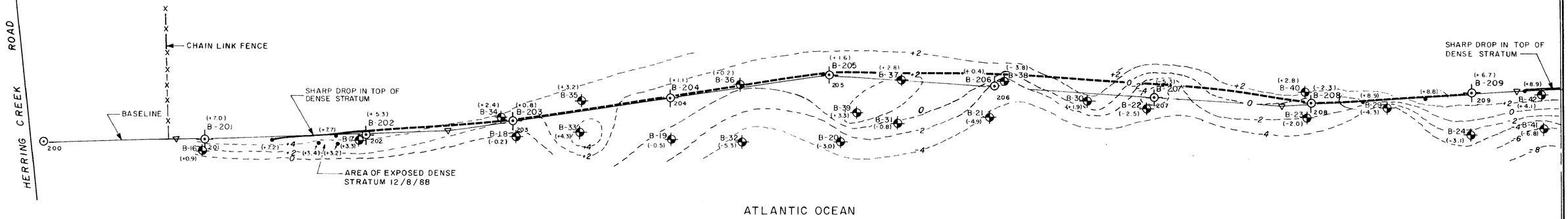
ATLANTIC DRIVE

NOTES:

1) BASE MAP AND BASE LINE DEVELOPED FROM PLANS PROVIDED BY SCHOFIELD BROTHERS, INC. ENTITLED "PLAN OF LAND IN EDGARTOWN, MA" DATED 10/17/88, DRAWING No. MV-1284.

2) THE LOCATION OF THE BORINGS WERE DETERMINED BY STADIA. THIS DATA SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

3) TOP OF DENSE SAND AND GRAVEL CONTOURS ARE BASED ON DATA FROM WIDELY SPACED EXPLORATIONS AND SEISMIC REFRACTION SURVEY AND REFLECT ELEVATION ON THE DATE EXPLORATIONS WERE MADE. ALL ELEVATIONS ARE REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929 (N.G.V.D.).



ATLANTIC OCEAN

N

LEGEND:

- (+3.4) — ELEVATION OF EXPOSED TOP OF DENSE STRATUM ON DEC. 5-9, 1988.
- (-0.2) — INDICATES ELEVATATION OF TOP OF DENSE STRATUM ON DATE OF BORING. (N.G.V.D.)
- B-18 — BORINGS PERFORMED BY GZA DRILLING, CO. ON DEC. 5-9, 1988.
- 210 — CONTROL POINTS ON BASE LINE SPACED 240 FT ON CENTER.
- B-210 — BORINGS PERFORMED BY GZA DRILLING ON OCT 18-19, 1988
- B-210 / 210 — BORING AND CONTROL POINT (SAME LOCATION)
- TURNING POINTS FOR BASELINE
- SEISMIC REFRACTION SURVEY LINES
- APPROXIMATE ELEVATION OF CONTOURS OF TOP OF DENSE SAND AND GRAVEL (N.G.V.D.).

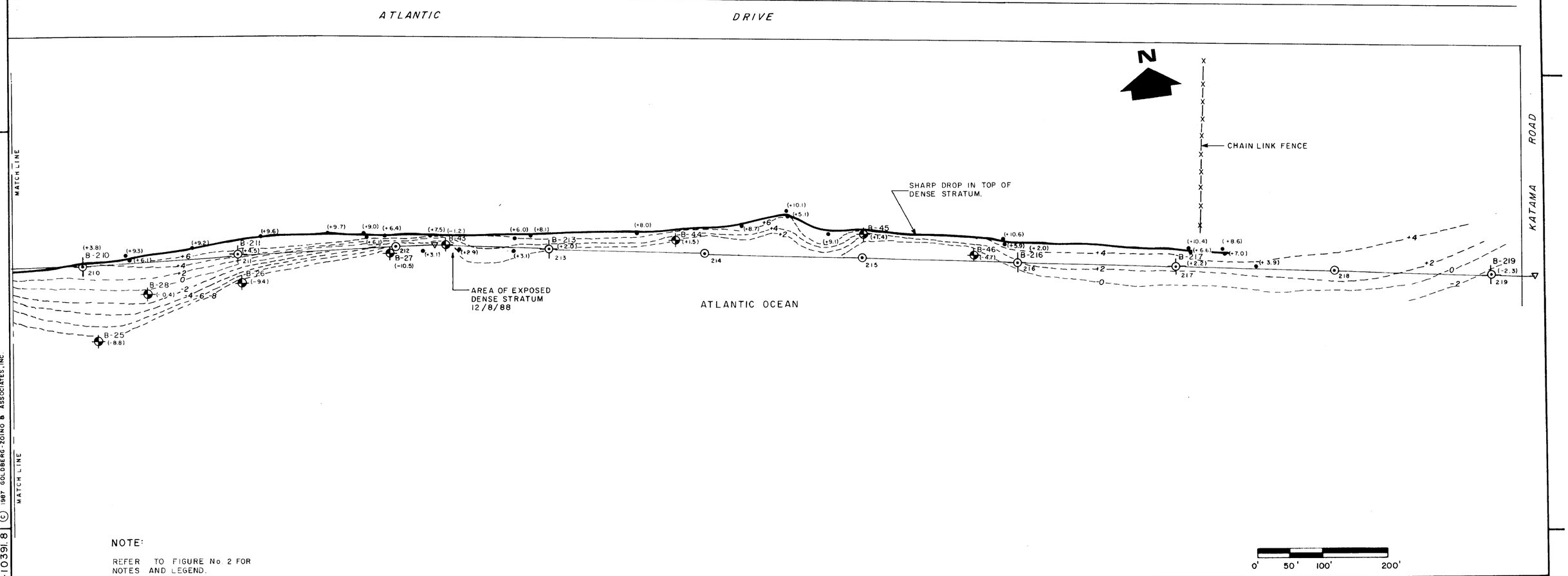
0' 50' 100' 200

SOUTH BEACH SEISMIC SURVEY EDGARTOWN, MASS.	TOP OF DENSE STRATUM SHEET 1 OF 2
	DEC. 1988 — FIGURE No. 2

GZA MAKEPEACE

FILE No. U-10391.8

138635



NOTE:

REFER TO FIGURE No. 2 FOR NOTES AND LEGEND.

FILE No. U-10391.8

GZA

MAKEPEACE

SOUTH BEACH SEISMIC SURVEY

EDGARTOWN, MASS.

TOP OF DENSE STRATUM

SHEET 2 OF 2

DEC. 1988

FIGURE No. 3

APPENDIX A

LIMITATIONS

APPENDIX A

LIMITATIONS

Explorations

1. The analyses and recommendations submitted in this report are based in part upon the data obtained from subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it will be necessary to reevaluate the recommendations of this report.

2. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more erratic.

Use of Report

3. This report has been prepared for the exclusive use of the New England Division, Corps of Engineers for specific application to the South Beach located in Edgartown, Massachusetts, in accordance with generally accepted soil and foundation engineering practices. No other warranty, express or implied, is made.

4. This soil and foundation engineering report has been prepared for this project by Goldberg-Zoino & Associates, Inc. This report is for design purposes only and is not sufficient to prepare an accurate bid. Contractors wishing a copy of the report may secure it with the understanding that its scope is limited to design considerations only.

APPENDIX B

SEISMIC REFRACTION SURVEY METHODOLOGY

APPENDIX B

SEISMIC REFRACTION SURVEY METHODOLOGY
SOUTH BEACH, MARTHA'S VINEYARD

Introduction

A seismic refraction survey was performed along a pre-surveyed traverse and where control points existed during the last week of October 1988 on South Beach, Martha's Vineyard. The purpose of this effort was to obtain estimates of depth of a certain dense layer immediately below the dune and beach sands on this same traverse.

Methodology

A Bison Geopro 12-Channel Signal Enhancement Seismograph was employed along with twelve 40-Hertz geophones situated in a linear array along the traverse. The geophones were spaced 20 feet apart with the entire array (or spread) situated 10 feet from control stakes that had been previously established at the site at distances of 240 feet along the traverse. The seismic energy source (a 16-pound hammer blow on a steel plate on the ground's surface) was exercised at each stake and on either end of the array as the survey proceeded along the traverse. For example, the survey commenced with the array situated between stakes 202 and 203; one end of the array was 10 feet from stake 202 and the other end was 10 feet from stake 203. Seismic refractions were recorded after exercising the source at stake 202. Then seismic refractions were recorded after exercising the source at stake 203. Thereupon the process was repeated by moving the spread of geophones between stakes 203 and 204 and so on until the entire staked traverse was surveyed.

Upon completing the data acquisition, each recorded seismogram was processed to enhance the timing of the refraction events obtained. Estimates of time information of refraction events observed at each of the twelve geophones were obtained and plotted as a function of distance from the energy source. This construction permitted estimates of the refracting layer's velocity and subsequent estimations of the refracting layer's depth below the geophone spreads.